States of Matter

What do trees, air, and water have in common? They all have matter. That means they take up space. Everything found on earth can be grouped into one of three states of matter: **Solid, Liquid**, or **Gas.**

**Solids** have a definite shape, mass and volume. They are made up of tiny particles called atoms which are packed closely together, and hold the solid in a definite shape that does not change.

**Liquids** do not have a definite shape, but they do have definite mass and volume. Liquids are similar to solids because their atoms are close together. What makes a liquid different is that those atoms can move around. Liquids can change shape by flowing and take the shape of their containers.

**Gases** do not have definite shape or volume. Like liquids, gasses will take the shape of their containers. If a gas is not in a container, it will spread out indefinitely. This is because the atoms in a gas are spaced farther apart than in a solid or a liquid which allows them to move about freely.

Matter can change from one state to another if heated or cooled. This is called a phase change. During a phase change, energy is transferred between a substance and its surroundings. A “phase” describes a physical state of matter. Things only move from one phase to another by physical means. If energy is added (like increasing the temperature) or if energy is taken away (like freezing something), you have created a physical change.

The six phase processes that occur as matter changes from solid to liquid and gas and back are:

**Melting:** is the phase change as a substance changes from a solid to a liquid. In ice, attractions between water molecules keep the molecules in fixed position. When ice cubes are removed from the freezer and placed in an empty glass, heat flows from the air to the ice. As the ice gains energy, the molecules vibrate more quickly. When all the molecules have enough energy to move, melting is complete.

**Freezing:** is the phase change as a substance changes from a liquid to a solid. When liquid water is placed in a freezer, energy flows from the water to the air in the freezer, and the water cools down. At the freezing point of water, some molecules move slowly enough for the attractions between molecules to have an effect. When all the molecules have been drawn into an orderly arrangement, freezing is complete.

**Condensation:** is the phase change as a substance changes from a gas to a liquid. Have you ever come out of a shower to find your bathroom mirror clouded over? The cloud on the mirror is caused by water vapour that cooled as it came in contact with the mirror. The water vapour transferred heat to the mirror and condensed into liquid water.

**Vaporisation (Evaporation):** is the phase change as a substance changes from a liquid to a gas. If you go outside after a rain shower on a sunny, warm day, you may notice puddles of water. If you return to the same location after a few hours, the puddles may be gone. This disappearance of the puddles is due to evaporation.

**Sublimation:** is the phase change as a substance changes from a solid to a gas without passing through the intermediate state of a liquid. Dry ice is the common name for the solid form of carbon dioxide. At room temperature, dry ice can directly change from a solid to a colourless gas. As dry ice sublimes, the cold carbon dioxide vapour causes water vapour in the air to condense and form clouds.

**Deposition:** is the phase change as a substance changes from a gas to a solid without passing through the intermediate state of a liquid. Deposition causes frost to form on windows. When water vapour in the air comes in contact with cold window glass, the water vapour loses enough kinetic energy to change directly from a gas to a solid.

**Particle models of Solids, Liquids and Gases.**

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| **Solid** | Particles of solids are held in place by strong electrostatic forces and are densely packed together. Particles of solids vibrate constantly due to their internal energy but they cannot move from one place to another. Particles of solids possess only vibrational energy. |
| **Liquid** | Particles of liquids are kept together by forces of attraction that are weaker than those of solid particles. Within the walls of the container they can move from place to place bumping into the sides of the container and into other particles. This type of energy is called translational energy. This energy gives a liquid the ability to flow and be poured and to spread when a liquid is spilled. Liquid particles also have vibrational energy. |
| **Gas** | Particles of gases are more rarefied than either liquids or solids. This means that the forces of attraction that hold them together are very weak and that the spaces between them are much larger than the spaces between solid and liquid particles. Particles of gases can move from place to place within a container bumping against the walls of the container and against other particles. They rotate and vibrate at the same time. Particles of gases have rotational, translational and vibrational energy. This explains why they can escape from a container very easily and they can put pressure on the side of the container (example – a balloon or a tyre). |

<http://www.education.leeds.ac.uk/assets/files/research/cssme/ns-tu/explaining_change_processes.pdf>

**Phase Change Diagram**

**Particle Behaviour:** [**http://www.youtube.com/watch?v=Hsu3JoXN-qU**](http://www.youtube.com/watch?v=Hsu3JoXN-qU)